for instability. But a horizontal vortex was produced both in the experiment and in nature (if we assume the hypothesis of Wegener and Krebs to be correct). That is, it occurred regardless of whether the strata producing the discontinuity favored stability or instability.

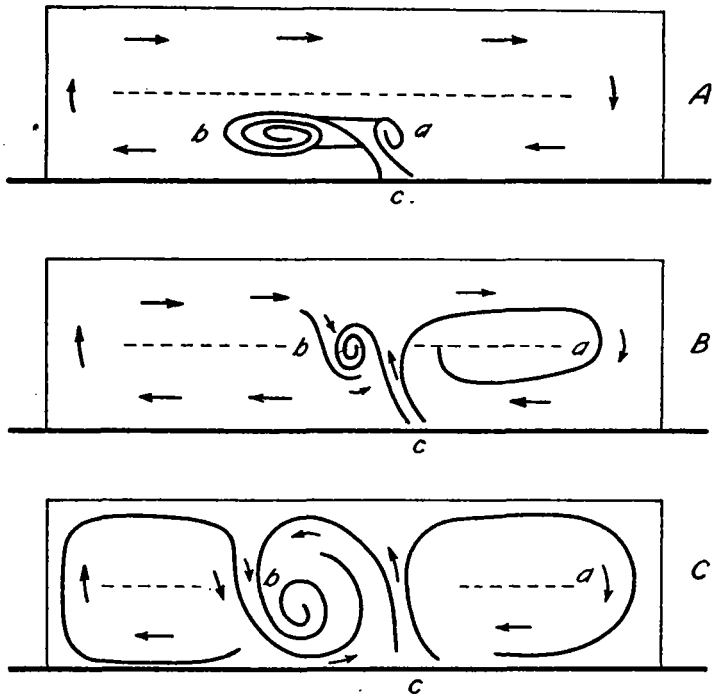

FIG. 1.—The experiment of Vettin: Forming a vortex by breaking through a discontinuity. (After fig. 85 in "*Wind und Wasserhosen in Europa.*")

In the phenomena discussed above, there seems to be a basis for believing that neither the thermodynamic hypothesis nor the mechanical, alone, adequately accounts for the inception of a tornado. Certainly the puncturing of a discontinuity, above and below which are winds of greatly contrasted velocity, by a convectional upthrust, suggests a query as to whether we may not expect further aerological investigation to show that both thermodynamical and mechanical principles must be invoked to solve the riddle. If such be the case, the view of Ferrel and others, according to which the thermodynamic principles play the major part, and the view of Wegener and Krebs with its emphasis on the mechanical, must share the honors of the middle ground. The example of Dr. van Everdingen's study of a special case may well be followed by other investigators.

Supplementary note.—Since the above material was prepared, Mr. J. E. Hissong's report on the tornadolike whirlwinds at the San Luis Obispo oil fire (see p. 161) has been received. The reader will note in the last paragraph of that report a statement concerning the apparent relation between the occurrence of the whirlwinds and the passage of a windshift line, a relation which, if one may judge from the necessarily scanty data, seems to have been closely similar to that discussed by Dr. van Everdingen. The oil fire certainly furnished no mean convectional upthrust. That the passage of the windshift furnished a discontinuity is probably almost certain. Mr. Hissong says: "In view of the fact that the tornadoes were first noted just after the wind changed from southerly to northwest it is possible that they may have been caused by the strong convectional currents over the fire being given a rotational motion by the northwest wind."—*B. M. V.*

THE NATIONAL ELIMINATION BALLOON RACE FROM LITTLE ROCK, ARK., APRIL 29, 1926

By JOHN A. RILEY

[Aerological Station, Broken Arrow, Okla.]

On the 28th, meteorological conditions ideal for the race began to be indicated and so it proved at Little Rock on the 29th, which was a warm, sunshiny day, with light southwesterly winds. Fair weather also prevailed quite generally over the Central and Eastern States, an unusually favorable condition considering that the region is normally visited by frequent rains and thundershowers at this season. With a bright moon throughout the night the pilots were able to recognize towns, rivers, and mountains and thus to know their positions at all times both night and day.

The meteorological controls in effect on the 29th were first to be recognized on the weather map of the 26th; a HIGH had appeared on the North Pacific coast and a LOW was moving eastward across Manitoba. Surface conditions on the day of the race were dominated by this HIGH, which had moved southeastward and now overlay most of the Southern and Eastern States, with a crest over the Ohio and lower Mississippi Valleys. Sea level isobars extended nearly straight NE–SW. Meanwhile the northern LOW had moved eastward across the lake region and was located over New Brunswick on the 29th. It had brought considerable cold air over the Northeastern States, while the Southwest was enjoying the mild tem peratures of early summer. The resulting temperature differences in the free air caused, above 1,500 meters, a cyclonic system of winds centered over New England and covering the country from the Mississippi Valley eastward.

Northwesterly winds therefore prevailed in the upper levels while below 1,000 meters the winds conformed nearly to the sea level isobars, i. e., they were SW. to WSW. over Arkansas and nearly west farther north and east. An observation at Little Rock at noon showed typically light winds to 2,000 meters, from west to southwest below 1,000 meters, and northwest above.

The balloonists could have chosen a course variously from northeast to southeast depending on the altitude, but the northwesterly wind could be ruled out of consideration not only because its speed was decreasing but because even had strong winds persisted a record breaking distance could not have been made in that direction before reaching the Gulf coast. Southerly component winds were greatly to be preferred.

The race was therefore necessarily a low altitude one at least at the beginning; to gain the greatest final distance it was desirable to make as much northing as possible the first night, as it was strongly indicated that westerly winds then prevailing over the Ohio Valley would continue for some time, and that little or no further progress northward could be made after reaching that region or during the second night. Thus, other conditions being favorable, the Atlantic might be the limiting factor for distance. This proved to be true for Mr. Van Orman, the winner, who decided to land when he sighted the lighthouse of James Bay shortly after midnight, May 1.

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As the wind was light during the afternoon the inflation of the balloons was an easy task and the take-off was as gentle as perfect equilibrium could make it. There were nine contestants, each with a balloon of 35,000 cubic feet foot capacity. A tenth balloon, the *Skylark*, of 20,000 cubic feet, was the pilot. It left at 4:25 p. m., taking a course ENE., changing to NE. as it gained altitude. The first contestant, the *S–21*, rose at 5 p. m. and the others followed precisely at five-minute intervals. The *Skylark* was lost to view before the departure of the others, which were all visible as they drifted northeastward a few hundred feet above the horizon.

Each pilot was supplied with current meteorological data before his departure. This included the morning weather map and auxiliary charts prepared by the Weather Bureau office at Little Rock. Telegraphic reports based on special noon observations at aerological stations were plotted at the field on a series of small outline maps showing the wind at various levels; each pilot carried a copy of these.

On the basis of current observations the contestants were advised to fly at an altitude somewhere near 500 meters, in order to gain the greatest northward drift and the greatest speed, for in this region night winds with southerly components show a well marked tendency to build up a maximum velocity near that level. (See Gregg: *Aeronautical Meteorology*, p. 47.)

A pamphlet on "Normal Flying Conditions in Arkansas during April and May" had been prepared by Mr. Gregg for the contestants. Some of its instructions were so applicable to this race that further information could have been dispensed with. For instance: "The best altitude for flying at night is normally about 500 meters, where in this section of the country, a fairly steady southerly wind often prevails. During the daytime better flying conditions usually are found at a greater altitude, 1 to 3 kilometers or higher."

Several of the contestants, including Van Orman, Boettner, Thaden, and others, reached equilibrium at 300 to 500 meters where they found the wind they desired carrying them to the northeast. They crossed the Mississippi River near Cairo at midnight and later and were carried thence nearly eastward across Kentucky. At least one balloon, the *S–23*, which flew at a higher altitude, and the *Skylark*, flying only a little above the tree tops, were carried more to the east into Tennessee.

By the morning of the 30th the southeastern HIGH extended as a ridge from Mississippi eastward and far out to sea. With another LOW moving eastward across the lake region, isobars were nearly east–west over Kentucky and Tennessee where the balloons were then located.

As the surface winds had a slightly stronger south component than the winds higher up, the pilots were confronted with the following problem: They might continue to fly at the same low altitude, in which case, on account of daytime convection, the chances were that while better progress might be made, a serious loss of ballast would be necessary to overcome the effects of vertical currents. If they rose higher, thus sacrificing somewhat of speed and direction, they would be in a better position to remain in the air longer.

As most of the contestants dropped out during the afternoon of the 30th, it is evident that the fight with convection was too much for their ballast supply. Pilot Naylor, of the *Skylark*, and his aid, who early on the first evening ran into trouble by catching their drag rope in the top of a dead tree, from which they extricated it with difficulty, decided to land about noon, when from an altitude of 6,500 feet the timbered slopes of the mountains of eastern Tennessee loomed ahead. Boettner, farther north, landed near the foothills of the Appalachian Mountains in southern West Virginia at 7:45 p. m., after passing over the Cumberland Mountains at 10,000 to 12,000 feet. The *S–21*, with Powell and Early aboard, was the only one to cross the Appalachians on the 30th. All the other contestants who landed on the 30th were farther north and came down in eastern Kentucky. The *Detroit*, piloted by Thaden and Williams, was forced down at 2:10 p. m., the drag rope having fouled during an attempt to get farther north with the surface winds.

Captain Gray, pilot of the *S–23*, who was longest in the air, kept an altitude of 6,000 to 10,000 feet during the daytime of the 30th while crossing the mountains in Tennessee and North Carolina. He made slow speed during the latter part of the trip, for he landed near Mount Holly, N. C., at 12:08 p. m., May 1, while the *S–21* had reached nearly the same vicinity at 5 p. m. of the 30th. That he was nearly becalmed is confirmed by the morning observation at Due West, S. C., where light winds were reported at all altitudes, veering from northwest and north near the surface to east at 1,500 meters. Observations in Maryland and Virginia on May 1 show that Van Orman also would soon have run into contrary winds attending a LOW over Washington, D. C., had he not been stopped by the ocean.

From the accompanying map it may be seen that the balloons followed closely the sea level isobars along the west and north periphery of the southeastern HIGH. Fair weather continued; the greatest menace to safety

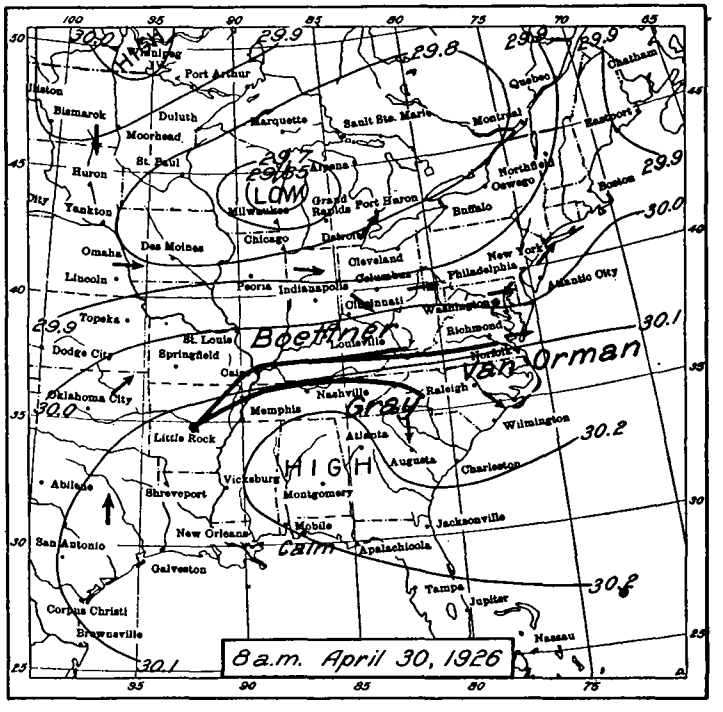

FIG. 1.—Sea level isobars, wind directions at 1,000 meters, and paths of the three balloons making greatest distance, National Elimination Balloon Race, from Little Rock, Ark., April–May, 1926

in free-ballooning, the thunderstorm, was absent; thunderstorms were reported in Pennsylvania, however, during the night of April 30–May 1. No serious accidents marred the race, although the press reported that Lieutenant Gray was injured, his clothing ruined, and the

balloon, *S-20*, damaged when it was forced down into trees near Reedville, Ky.

A new menace, nonmeteorological in character, was reported by some of the pilots: while they were sailing over the mountains of Kentucky and Virginia, several of the mountaineers proceeded to shoot them up. As none of the balloons was hit, it was evidently merely an admonition from these native sons for the pilots to keep on their way.

A very complete schedule of broadcasting weather information for the pilots was carried out with a high degree of success. From the log of the *Goodyear IV* we learn that messages and programs were listened to during the first night from stations in New York City, Cincinnati, Memphis, Hot Springs, and Los Angeles. On the 30th mention is made of reports from Chicago, St. Louis, and Pittsburgh. Van Orman in a telegram to the Chief of the Weather Bureau says, "The weather data furnished at Little Rock, also the flying and regular forecasts which were broadcast, helped us win the national race and establish new records. Every flying forecast broadcast was received, also 80 per cent of the regular forecasts. Please accept my thanks and convey them to the members of your Bureau who assisted."

In the table below are given some details of the race. It will be noted that the shortest distance covered by a contestant was 473 miles, with small increases in distance from one record to the next, except for the winner, who exceeded his nearest competitor by more than 200 miles. According to Ralph Upson, noted balloonist and starter of the race, the previous record for balloons of this size was 305 miles; even the smaller *Skylark* exceeded this by more than 100 miles.

Name of pilot and aid	Entrant	Name of balloon	Place and time of landing	Distance
				Miles
W. T. Van Orman (W. W. Morton).	Goodyear Tire & Rubber Co., Akron, Ohio.	Goodyear IV	8 miles SSE. of Petersburg, Va., 1:03 a. m. May 1.	848
Capt. H. C. Gray (Lieut. D. Johnston).	U. S. Army Air Service, Scott Field, Ill.	S-23	7 miles N. of Mount Holly, N. C., 12:08 p. m. May 1.	635
J. A. Boettner (H. W. Maxson).	Akron Chapter N. A. A., Akron, Ohio.	Akron N. A. A.	7 miles NE. of Welch, W. Va., 7:45 p.m. Apr. 30.	627
Lieut. James F. Powell. (Lieut. James F. Early).	U. S. Army Air Service, Phillips Field, Md.	S-21	12 miles due N. of Hickory, N. C., 5 p. m. Apr. 30.	618
Herbert V. Thaden (C. D. Williams).	Detroit Flying Club, Detroit Aviation Society.	Detroit	3 miles W. of Gulnare, Ky., 2:10 p. m. Apr. 30.	574
Lieut. Wm. A. Gray (Lieut. R. Kieburtz).	U. S. Army Air Service, Langley Field, Va.	S-20	Reedville, Carter County, Ky.,— p. m. Apr. 30.	570
Svend A. U. Rasmussen. (Edward J. Hill).	Detroit Adcraft Club, Detroit, Mich.	Detroit Adcraft	3 miles W. of Blaine, Ky., 5 p. m. Apr. 30.	566
Capt. L. F. Stone (Capt. G. R. Oatman).	U. S. Army Air Service, McCook Field, Dayton, Ohio.	S-19	7 miles SE. of Heidelberg, Ky., 2:30 p. m. Apr. 30.	510
Walter A. Ham (Robt. P. Lehr).	Walter A. Ham, Los Angeles, Calif.	Goodyear Southern California.	5 miles E. of Brodhead, Ky., 11 a. m. Apr. 30.	473
W. C. Naylor (K. W. Warren).	The Arkansas Gazette, Little Rock, Ark.	Skylark (pilot balloon).	4 miles N. of Crawford, Tenn., 11:30 a. m. Apr. 30.	410

551.578.1(794) NOTES, ABSTRACTS, AND REVIEWS

EXTRAORDINARY APRIL RAINS IN CALIFORNIA

The unprecedented rains in some parts of California in April, 1926, call for some mention of the attendant meteorological conditions.

On April 1, five days previous to the arrival of the rains, a weak cyclonic system was charted in W. longitude 150°; N. latitude 30°; associated therewith was an anticyclone, centered in W. longitude 160°; N. latitude 50°. The latter, being in the more rapidly flowing eastward drift of the higher latitudes, advanced to the Mackenzie Basin by the evening of the 4th. Meanwhile the more slowly moving oceanic cyclone had increased considerably in intensity and it continued further to increase, reaching its maximum development on the morning of the 7th in W. longitude 135°; N. latitude 45°. Twenty-four hours previously an offshoot from it had passed inland over California giving the general and heavy rains as above noted.[1]

The oceanic cyclone on the morning of the 8th occupied practically the whole of the Pacific north of N. latitude 30 and east of W. longitude 170°; it also had encroached upon the continent as far as W. longitude 120° in Alaska and 110° in northwestern Mexico.

If, in the beginning, the position of the cyclone and anticyclone had been reversed, as is normally the case in that part of the Pacific, very little, if any, precipitation would have occurred in California. It is a basic maxim in the forecasting of precipitation in this country that the conditions are most favorable when the geographic position of the cyclone and the anticyclone is such that the former is to the southwest of the latter.

This position was reached on the 5th and 6th and although the centers of the two formations were spearated by at least 30° of latitude the result was never in doubt and was quickly foreseen by the San Francisco forecaster. The chief meteorological factor concerned in the causation of the rains in question was the relative position in time and space of the two barometric formations above described.

As has been pointed out, that position was the exact opposite of the one normally to be expected, viz, high pressure over the northeast Pacific in approximately, W. longitude 148°; N. latitude 32°, in April and it was this abnormal pressure distribution that led to the rains in California.

The fact that heavy April rains have occurred once within the 50-odd years of observation can not, however, be interpreted to mean that similar heavy rains will occur in the next 50 years. It is within the range of probability that several occurrences of heavy rains in April may be experienced in the next 50 years and on the other hand there may not be a single occurrence.—*A. J. H.*

[1] Cf. Reed, T. R., p. 181 of this REVIEW.

551.578.1(265.1)

RAIN SQUALLS OF THE ATLANTIC TRADE-WIND REGION

K. Knoch, in Publication No. 335 of the Prussian Meteorological Institute (Berlin), 1926) discusses certain aspects of the temperature and relative humidity observations obtained by the late E. Barkow on board the ship *Deutschland* in the Atlantic trade-wind region during June, July, and August, 1911.

The rain squalls are phenomena apparently not related to the ordinary trade-wind cumulus. They occurred between latitudes 25° and 20° N. with a frequency averaging 1.9 per day, 3 per day between latitudes 20° and 15°, and 2 per day between 15° and 10°. In the 5-degree belt north of the Equator the frequency was 1, in 0° to 5° S. it was 3, dropped to 1.1 between 5° and 10° S., rose to 3 in the belt 10°–15°, and to 4 per day between 15° and 20° S. These figures are based, of course, on